Selection of representative groundwater monitoring wells – A compromise between site characteristics, data history, stakeholder interests and technological limitations

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Abstract

The inter-disciplinary project "Integrative Groundwater Assessment", looks into the effects of extreme hydro-meteorological events on the quantity and the chemical and biological quality of groundwater. Focus is on the Austrian Mur catchment, an area reaching from its alpine spring (~2000 m asl) down to the Slovenian border (~200 m asl). More than 500 state operated groundwater observation wells are available over the 400 km of the river's course with publicly available time series for water levels, going back to the 1960s.
However, for water quality, such time series rarely exist and if so, they often do not cover all specific parameters one needs, asking for targeted sampling campaigns. The availability of hundreds of wells seems like a benefit. However, the identification of wells that are representative and suitable for sampling regarding both chemical and biological parameters is a challenging task.
In this poster we show our multi-step process, taking into account climate regions, lands use, aquifer geometry, stakeholder input and technical limitations that resulted in less than 10% of the available wells being suitable for our sampling campaign.
Currently, we're narrowing down this selection further, in order to be able to equip some wells with novel multi-parameter UV-Vis dataloggers that will allow us to monitor various quality data in an very high temporal resolution (multiple measurements per day).
For more details on the preliminary results, please see Birk et al., EGU21-13111, Integrative hydrogeo-ecological assessment of the quantitative and qualitative response of groundwater to hydrological extremes, https://doi.org/10.5194/egusphere-egu21-13111

Due to this years #vEGU21, this poster has been designed to stand on its own as a somewhat text heavy extended abstract. It should work as one, long, screen width filling PDF. If the poster is pixelated in your browser, please use your systems pdf viewer!
You are of course very welcome to comment on it or to ask me questions in the vPICO session.

1 Available wells and historical data

The aquifers within the Austrian part of the Mur river valley are monitored by 534 state operated wells. These wells' waterlevel time series are publicly available at the https://ehyd.gv.at/ website. Besides these, there's also a considerable number of further wells operated by various other (private) entities (local water supplies, power plant operators, highway authority, Austrian railways, companies and consultancies for brownfield remediation etc.).
- Time series of state operated wells go back to 1945 for some, most wells have been drilled between the late 1960s and early 90s.
- Time series are a mix of monthly hand measurements (oldest wells) to sub daily data (modern data loggers), aggregated to monthly data.
- Quality measurements are taken by the federal ministry for the environment on a subset of these wells, so some limited water quality time series also exist.

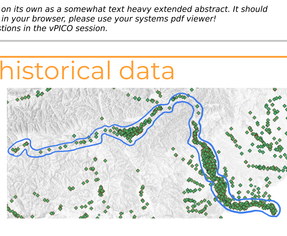


Figure 1: *Top image: Screenshot from ehyd.gv.at showing the available wells in southeastern Austria (green rectangles) with the Mur river valley highlighted in blue. Image width approx. 200 km. Bottom image: Subset of 84 locations that have been sampled by us (includes 12 non-governmental wells and 13 surface water samples). Green dots: full groundwater sample, red square: groundwater fauna sample, orange diamond: river sample, lilac cross: spring sample*

2 Access and technical limitations

Due to their long history, the available wells are of various types, ranging from dug wells with more than 1 m diameter to 1 inch piezometers. While most of the state wells are solely observation wells, some are also in use house or industrial wells.
Due to technical limitations (being able to fit an MP1 pump into the well and being able to purge it in a reasonable time frame) and in order to obtain comparable results, this eliminated a considerable amount of wells.
Furthermore a number of wells had to be eliminated because they had been destroyed by traffic or construction works or were impossible to find (see Fig. 2).

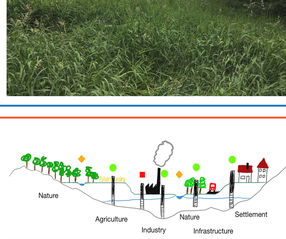
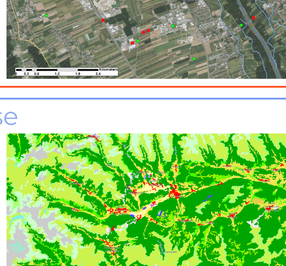


Figure 2: *There is a biologist and a well in this picture. We could recover the biologist but the well remains untraceable.*

3 Aquifer transects

In order to gain a thorough understanding of the aquifer, we do not only want to follow the aquifers along the course of the river, but we also want a longitudinal overview over the aquifers, from their contact with the basement rocks at their borders to the central river.
Thus the wells should be distributed in a pattern that allows us to get a good overview over the aquifer. In order to keep sampling time and costs reasonable, wells that are deemed to show the same signal are to be avoided. Again, this factor is another reduction of the set of possibly suitable wells, however, it has to be noted that due to the other factors, "perfect" transects are rarely possible.



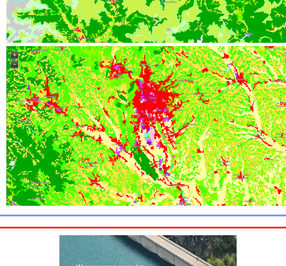


Figure 3: *Sketch of an idealized aquifer transect (top), sampling all possible land uses compared with an aerial view of a good, real transect (bottom). Green dots: full groundwater sample, red square: groundwater fauna sample, orange diamond: river sample. Yellow line: aquifer border*

3 Climate and land use

Due to its course from its alpine spring to the lowlands bordering the pannonian and mediterranean climate zones, the river Mur and thus its accompanying aquifers cover different climates, aquifer geometries and different land uses and other human factors.
In order to gain a thorough understanding of the whole Mur valley, we aimed to sample locations that represent these different factors while trying to avoid multiple samples that show the same signal, resulting in a further reduction of suitable wells.

Number of wells	Land use
31	Agricultural areas
5	Forests and semi-natural areas
12	Urbanised areas

Table 1: *Corine Landcover data for the sampled wells.*

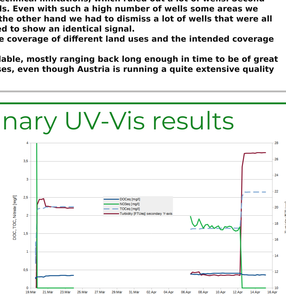
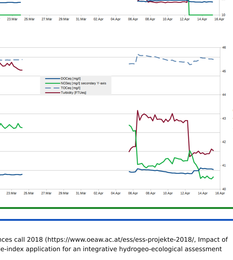


Figure 4: *Corine Landcover data for the upper Mur valley and the surrounding mountainous areas (top) and the area around the city of Graz (bottom), highlighting the differences between mostly forest and agricultural areas upstream (dark and light green colors) and mostly urban and industrial areas directly around Graz (red and violet colors). Image widths approximately 50 kilometers.*

4 Stakeholders

As a further step, discussions with stakeholders are an important part in selecting suitable wells. Besides access issues and finding well hidden wells (though not always successfully, see Fig. 2) a good relationship with stakeholders provides important insights into phenomena and features that are expected to be seen in certain wells. Furthermore, their needs can also be an important factor in selecting one possible well over the other.
In order to gain insights from stakeholders and to inform them about our work, we successfully conducted a workshop (see Fig. 5) with stakeholders ranging from government agencies to local water suppliers and the state chambers of agriculture, enabling us to learn about diverse standpoints and needs.


„Wasserressourcen im Klimawandel: Konsequenzen für Wasser-, Energie- und Landwirtschaft"
Informationsveranstaltung und Stakeholderoffen zum DAFA Forschungscluster Grundwasser
ÖAW
Zeitpunkt: 27.2.2020
Ort: Universität Graz, Hörsaal HS15,01, Resowi 8
DAFA Kalender unter: https://carbonladder.uni-graz.at/07/08/10202/
Wasserressourcen im Alpenraum sind in besonderem Maße von Auswirkungen des Klimawandels betroffen. Sowohl die Menge als auch die Qualität des Grundwassers ist entscheidend für Energiesektor und die Landwirtschaft und bislang noch unzureichend erforscht. Seit Mitte 2019 werden von der Österreichischen Akademie der Wissenschaften (ÖAW) vier interdisziplinäre Forschungsprojekte gefördert, die sich mit den Auswirkungen des Klimawandels auf die Grundwasserressourcen im Raum Kärnten und Steiermark bis hin zur Grenzziehung zwischen dem Projekt eingesetzt und zu einem Forschungsprojekt zusammenfassen lassen, welche Forschungsfragen aus Ihrer Perspektive aktuell besonders wichtig sind.
AUSGEZEICHNENDES UND ABFÜHRENDES PROJEKT:
Obenstehendes ermöglicht in einem weiteren anzugangen Experiment die Auswirkungen von Klimawandel auf die Grundwasserressourcen und den Wasserhaushalt und die Ökosäulende von beeinflussbaren Grundwasser.
Zum von Rechtsfrist zu Grundwasserressourcenbilanzgarantien zu bestimmen, deren zutreffige Änderungen und Auswirkungen auf die Landwirtschaft und Energiewirtschaft zu bestimmen, sowie die Ableitung von visualisierten Konsequenzen für die Landnutzung und die Wasserwirtsgarantien für Österreich abzuschätzen.
Das ausgezeichnetbewertete Assessment untersucht die Auswirkungen hydrologischer Extremereignisse auf den hydrologischen hydrochemischen und ökologischen Zustand von Grundwasserkörpern in den Alpen und deren Vorland, um kritikerzu zu erkennen, die sich zur Überwachung und Bewertung der Auswirkungen des Klimawandels auf Grundwasser eignen.
Ebenso erstreckt eine Methoden zur Charakterisierung von Struktur, Kapazität und Empfindlichkeit von Karstgrundwasserkörpernnen. Dies geschieht durch Kombination und neuartige Auswertung von Daten aus Bodenmessungen und einer neu entwickelten Zirkulatn-Flugzeitsonde.
Lehrstuhl für Landbau
Universität Hohenheim
Institut für Kulturtechnik und Bodenwasserhaushalt
Institute of Hydrology and Water Management
Institutionen Kärnten
Institutionen Steiermark
Institutionen Wien
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